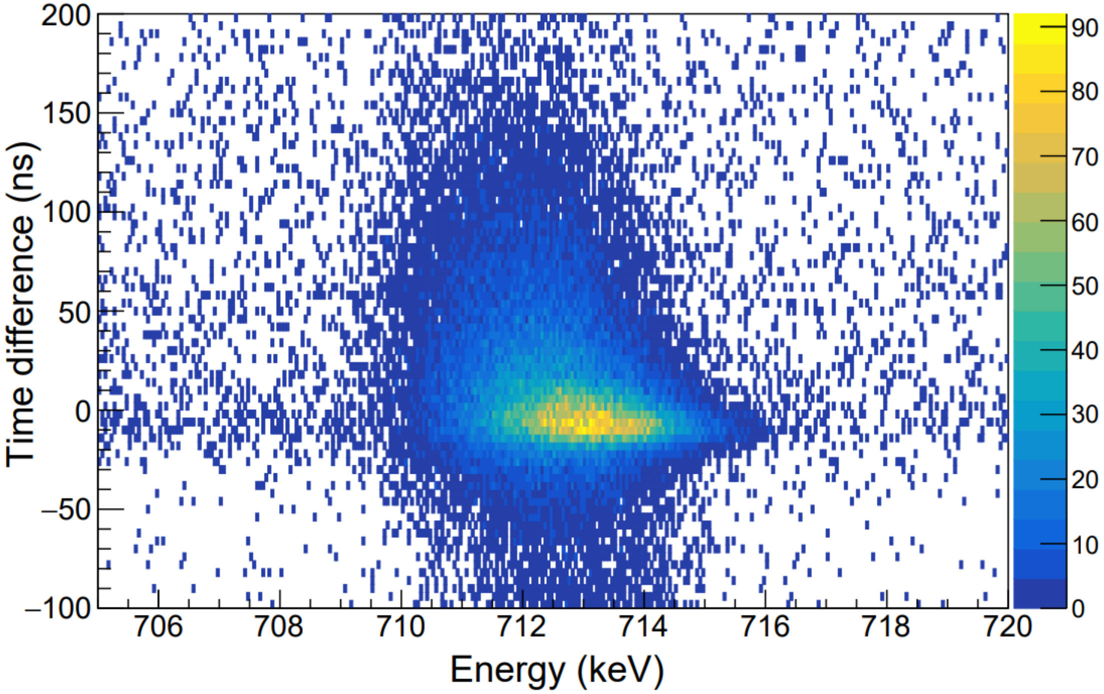
Update muX meeting 17/01

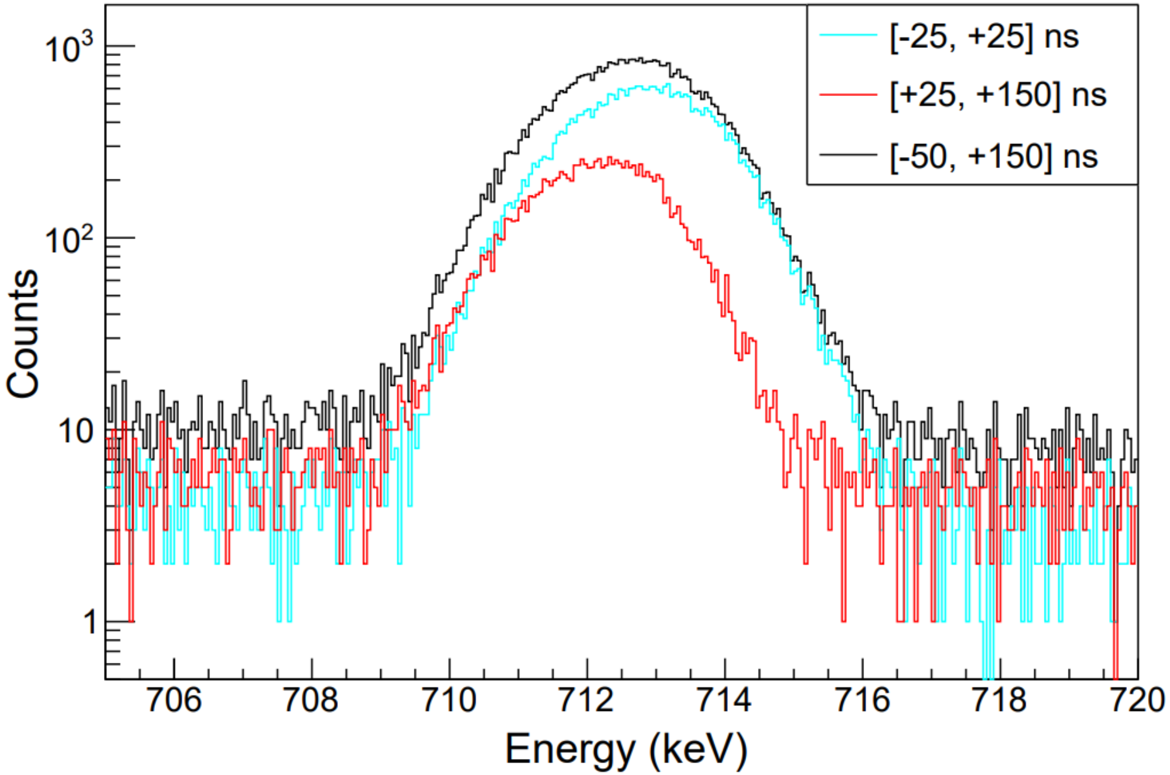
Michael Heines

Time cut systematic

Issue with bias time cuts

Centroid position is affected by choice of time cut!

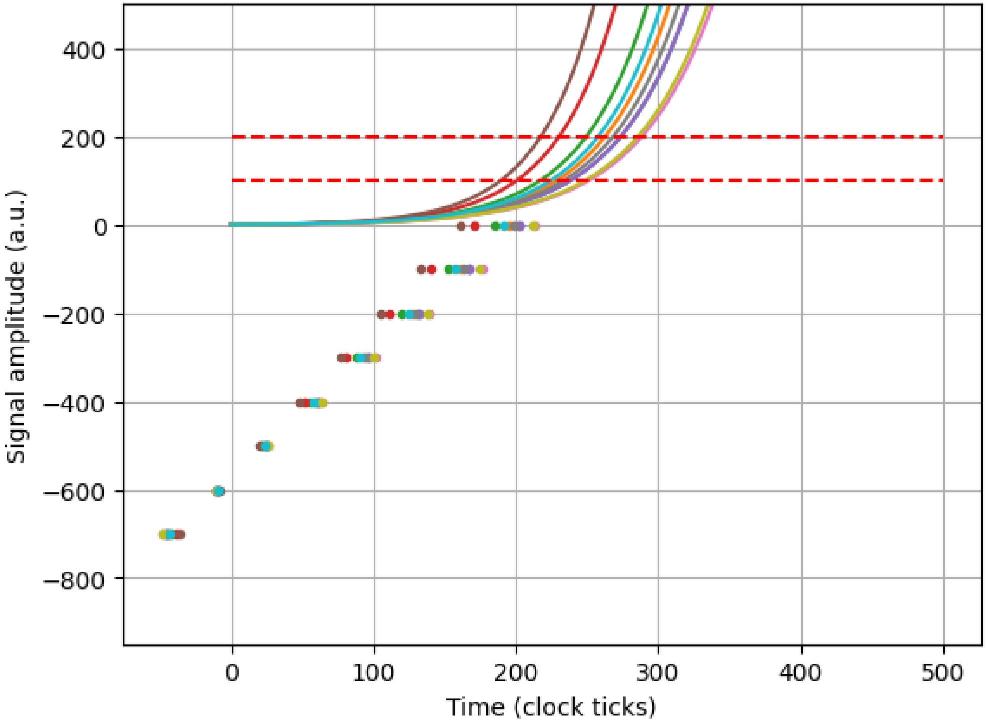




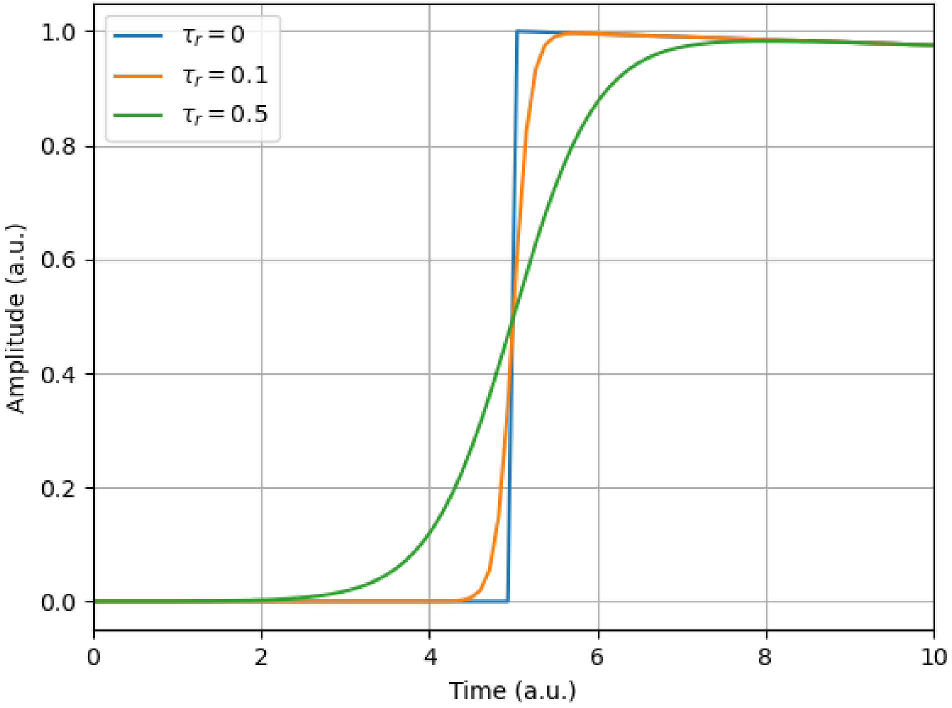
Ge09: Worst detector for this effect

Understanding the issue

- Slow rise time pulses are registered as “later”



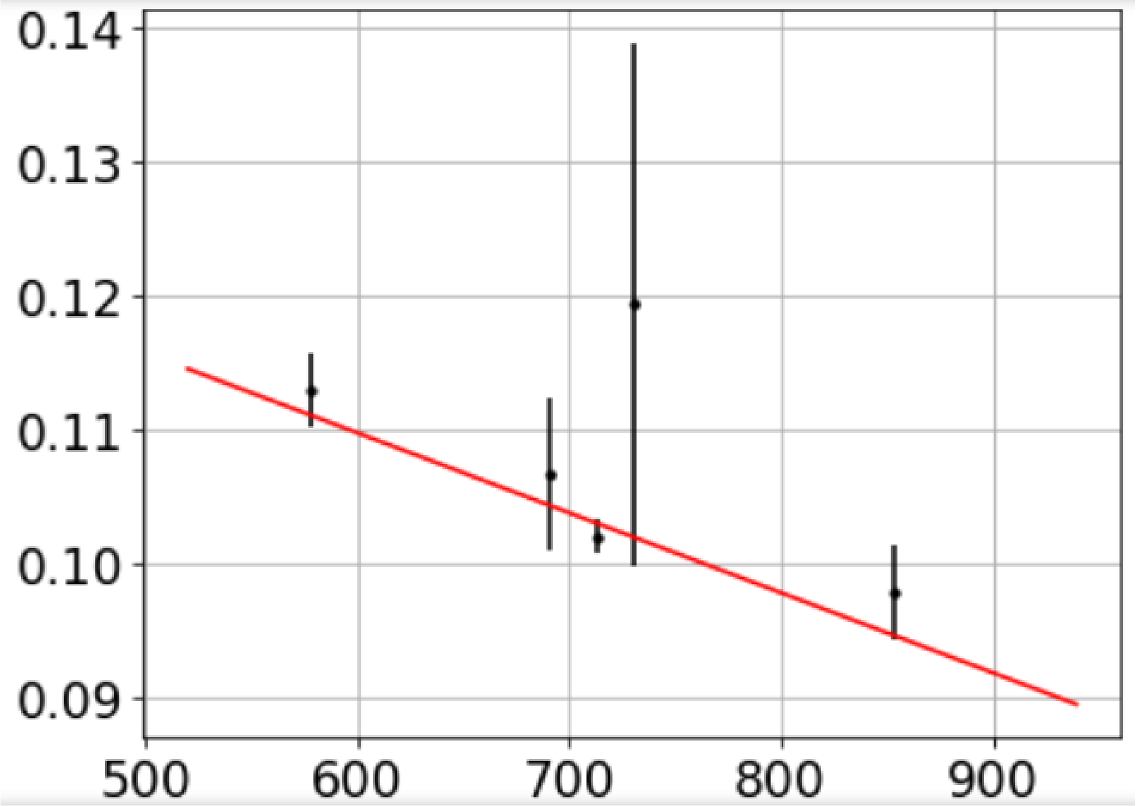
- Slow rise time pulses have lower energy



Correcting for it

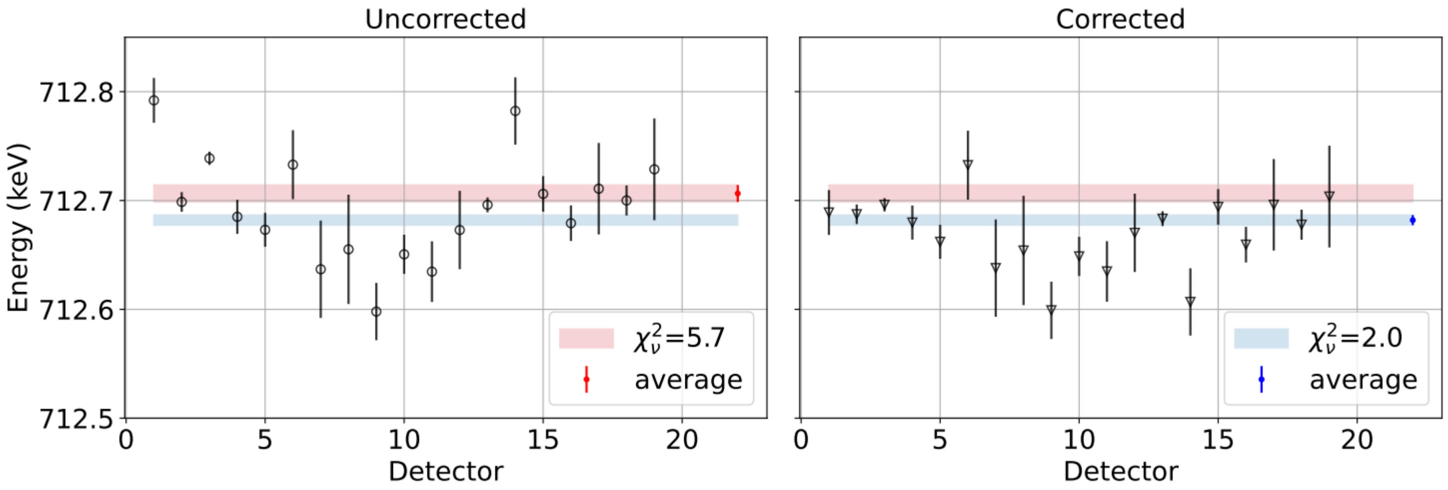
- Idea of correction:
  - Narrow time cut shifts output
  - Consider a broad time cut which takes all pulses
  - Probe the centroid difference in broad and narrow cut
  - Estimate shift at different energies → Linear fit

$$\delta = a_0 + a_1\, E$$



Quite big effect

Detector	a_0 (eV)	a_1 (10^{-5})	shift in ^{39}K 2p1s (eV)
Ge01	145.6(111)	−5.97(157)	103.0(11)
Ge02	56.6(111)	−6.35(156)	11.3(6)
Ge03	86.1(108)	−6.08(154)	42.7(8)
Ge04	15.6(52)	−1.45(75)	5.3(4)
Ge05	40.4(31)	−4.12(47)	11.0(5)
Ge06A	14.9(118)	−2.02(168)	0.5(9)
Ge06B	-0.5(105)	−0.08(162)	-1.1(17)
Ge06C	16.3(155)	−2.1(22)	1.1(10)
Ge06D	-12.7(122)	1.63(177)	-1.1(12)
MB07A	1.0(85)	0.13(126)	1.9(10)
MB07B	14.8(67)	−2.09(95)	-0.2(4)
MB07C	21(24)	−2.5(34)	2.6(12)
Ge08	53.6(43)	−5.74(68)	12.7(8)
Ge09	236(24)	−8.5(32)	175(3)
Ge10	43.4(71)	−4.42(104)	12.0(8)
Ge11	45.6(44)	−3.64(66)	19.7(6)
Ge12	27.7(49)	−1.82(73)	14.8(6)
Ge13	52.0(40)	−4.18(62)	22.3(7)
Ge14	63.4(83)	−5.39(118)	25.0(6)

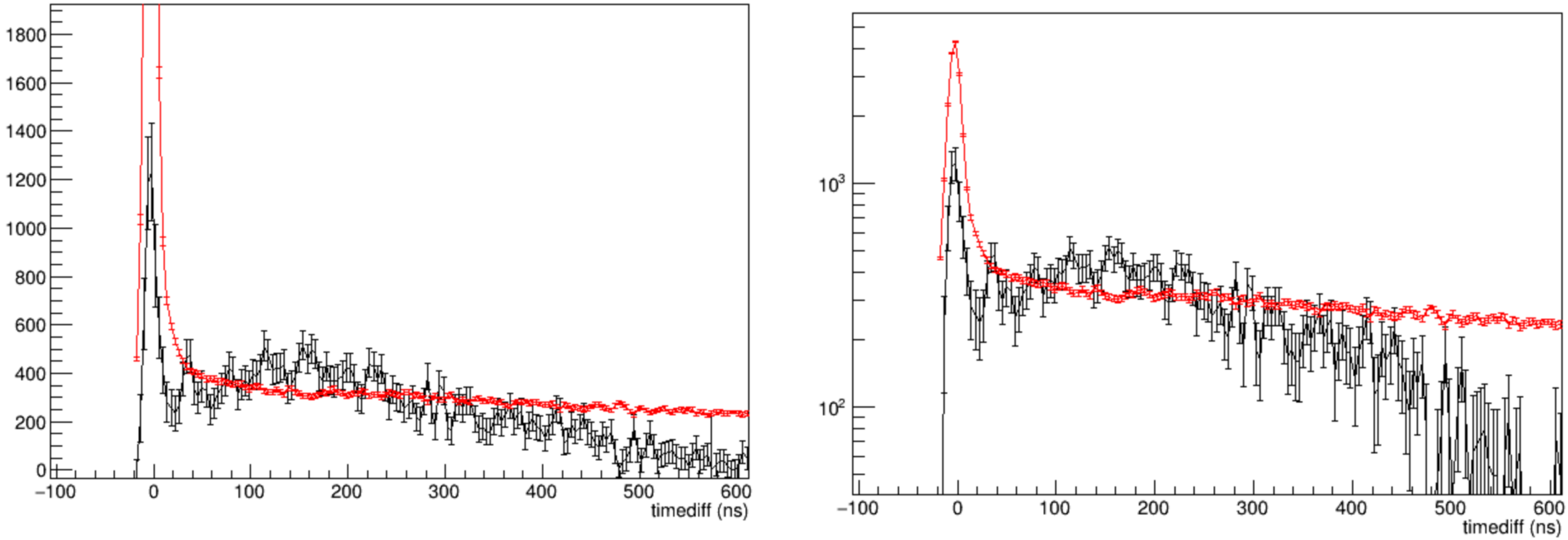


Ideal ^{40}K time cut

Time behaviour in ^{40}K data

Red: Background per keV
Black: Signal integral

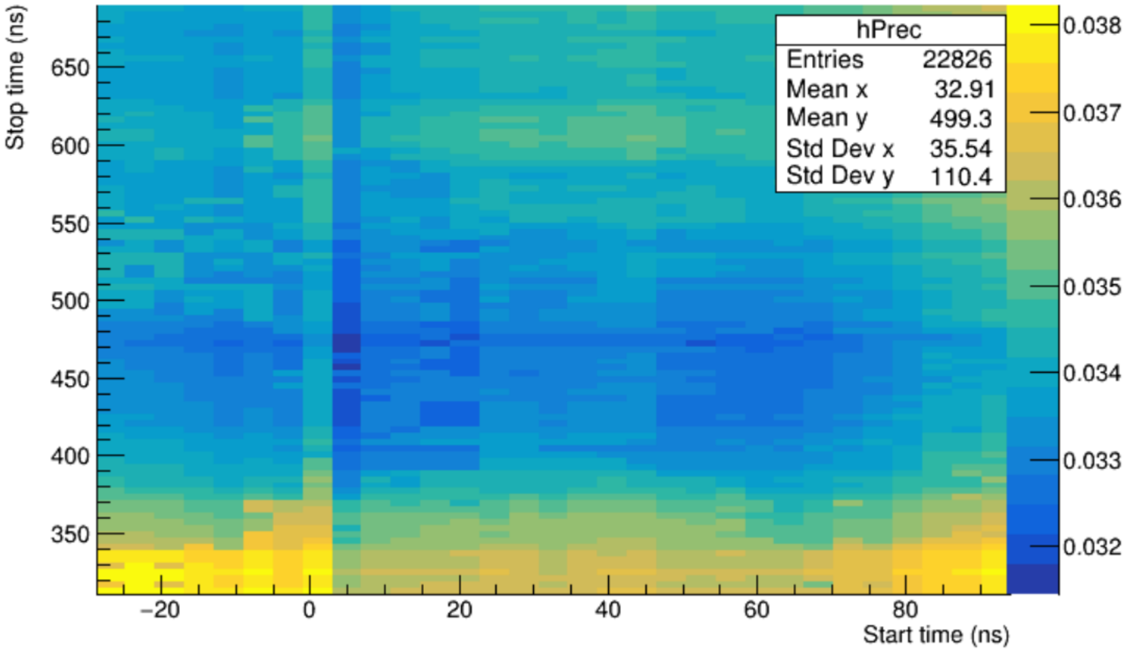
It makes sense to start after t=0 → Cut out Titanium 2p1s Compton continuum and edge



Best time cut for ^{40}K data

- Ideal start window: 2 local minima around 4ns and 60 ns
    - ➢ Minimal reduction in first local minimum
    - ➢ Opting for second to work with cleaner spectrum

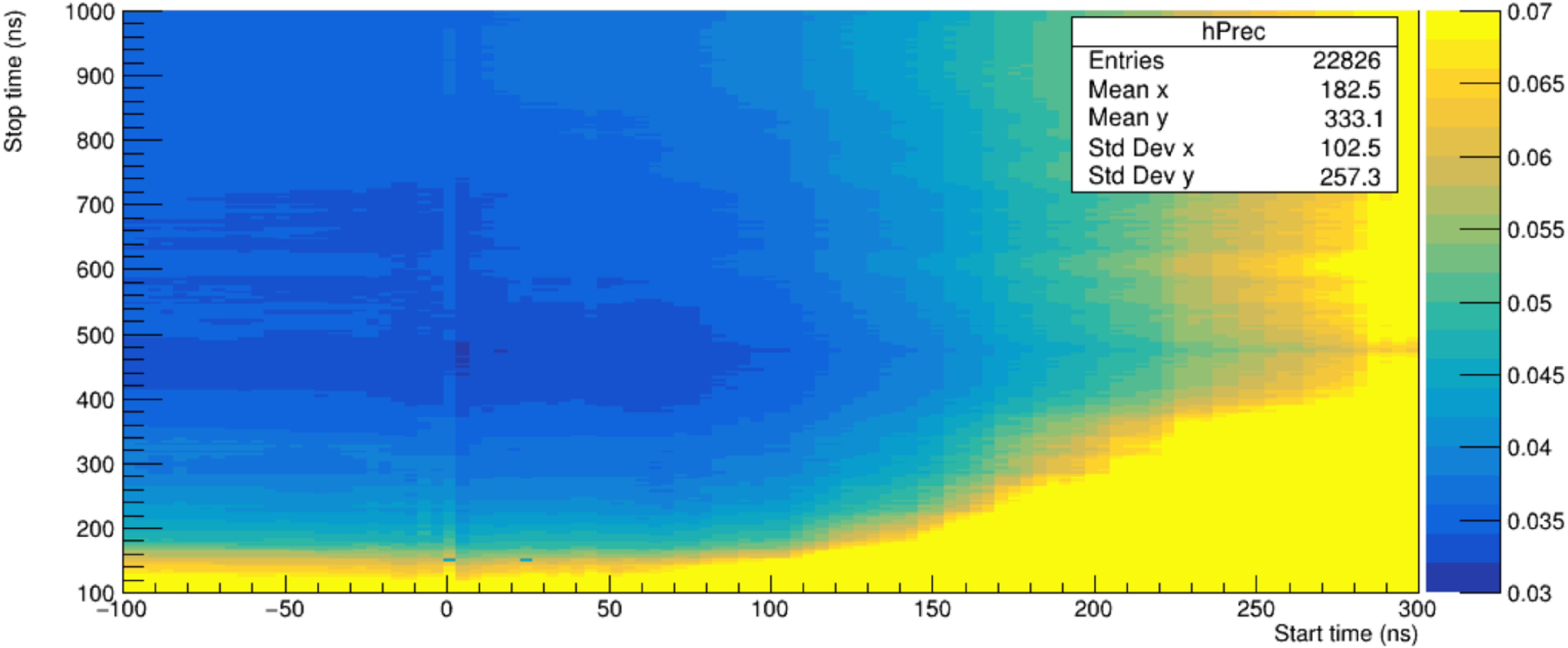
- Ideal stop window: Consistent around 480 ns



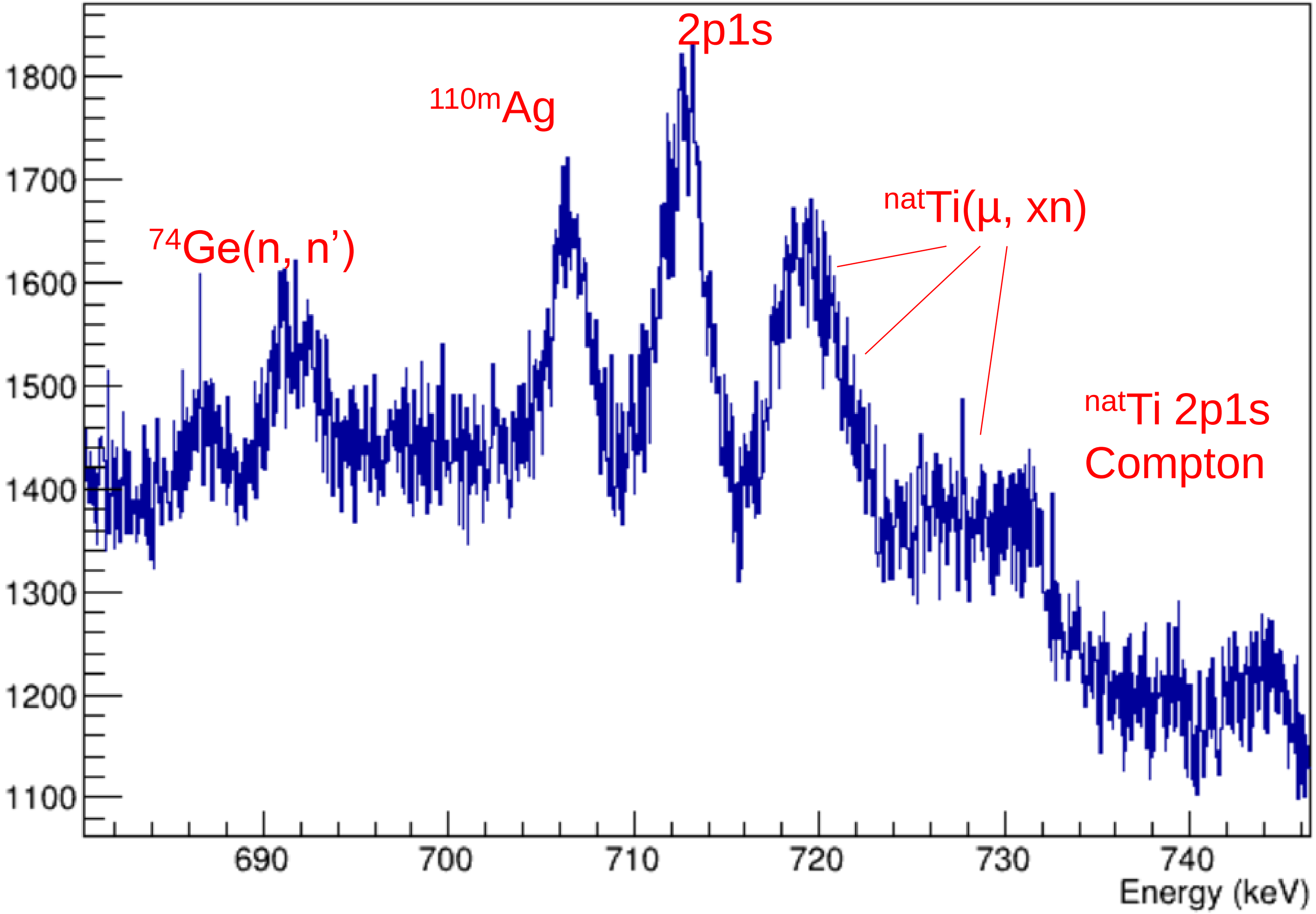
Best time cut for ^{40}K

Graph does not tell the fully story:

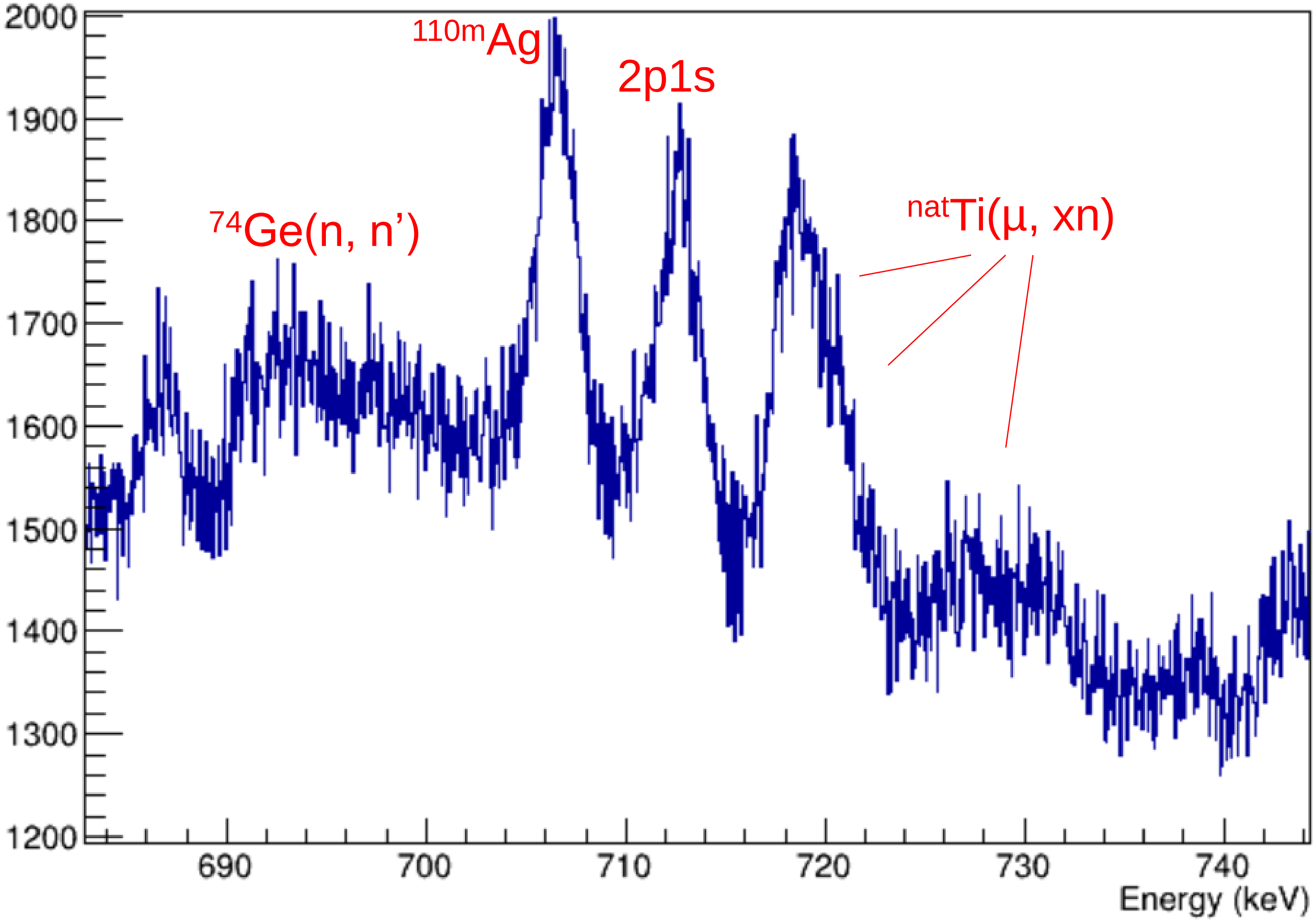
- Ti 2p1s Compton edge → Almost fully suppressed delayed
- Capture lines → Suppressed with delayed + shorter interval
- ^{74}Ge(n, n’) Scattering structure → Suppressed with delayed + shorter interval
- ^{110m}Ag calibration line → Suppressed with shorter interval



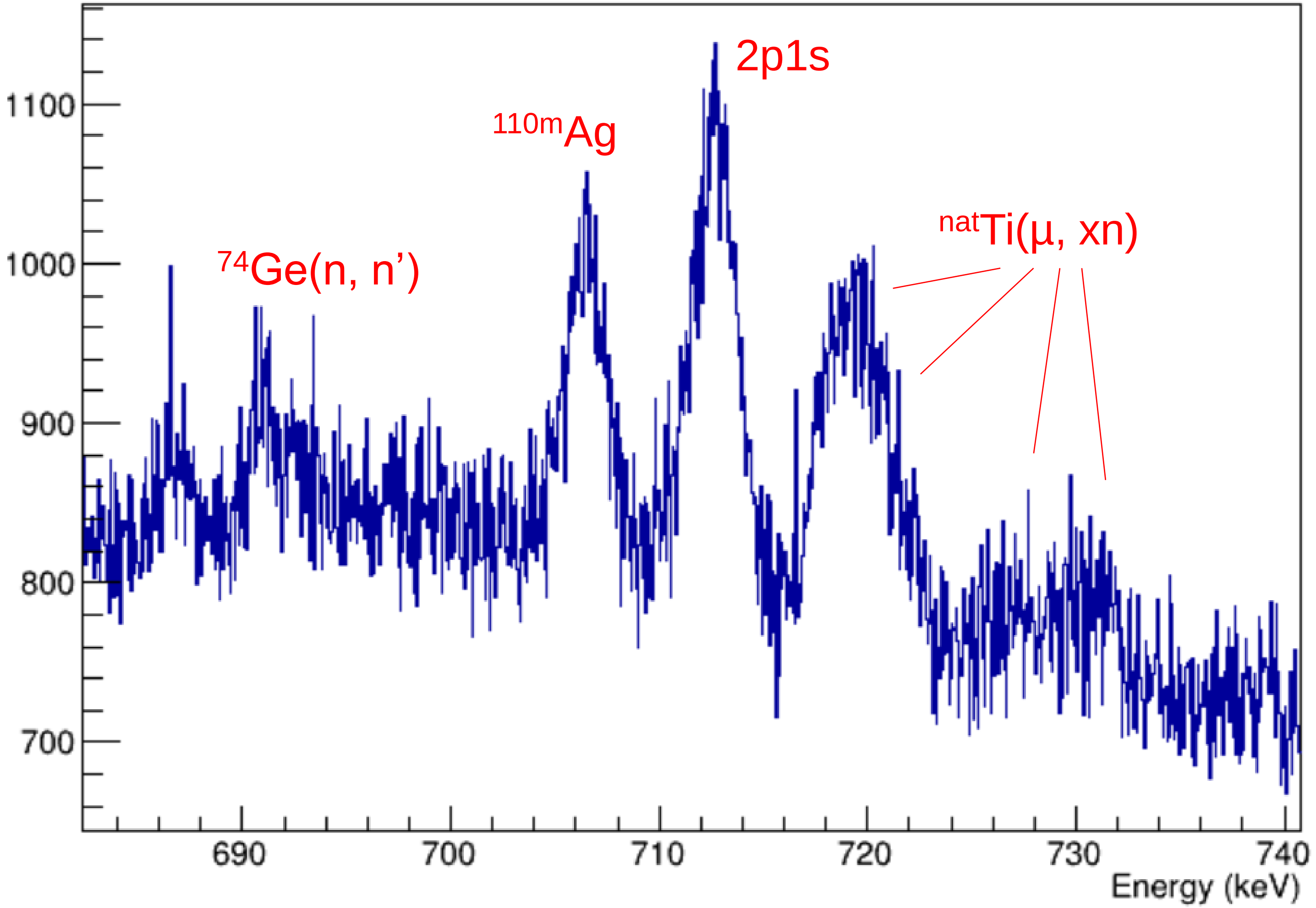
The standard [-50, 500] ns cut



Long delayed [50, 1000]ns cut



The finalized spectrum



Radius extraction

Nuclear polarization

- Contributions:
  - Nuclear part:
    - Low lying states (mostly uncorrelated between isotopes)
    - Giant resonance (highly correlated between isotopes)
  - Nucleon part:
    - nucleon polarization (highly correlated between isotopes)

NP uncertainties

- Error on nuclear part based on spread based off ^{40}Ca → ~20%
- Error on nucleon part based of Misha's estimates → ~10%
- Adding uncertainties linearly as a conservative estimate

- 35Cl : NP = 103.9(208) +14.8(15) = 118.7(223) eV
- 37Cl : NP = 100.1(201)+16.0(16) = 116.1(217) eV

- Relative uncertainty of ~19%

NP differences

- Assume:
  - 100% correlation in giant resonance and nucleon parts
  - 0% correlation in low lying states part

- Will get exact partitioning soon, but based of rough estimates, the total correlation becomes ~91%

- Cl $\Delta NP \approx$ 2.6(94) eV → ~8% of largest NP value compared to Fricke's assumption of 10%

Abusing correlation for $\delta < r^2 >$

$$\delta < r^2 > = R_2^2 - R_1^2 = (R_2 \ - R_1)(R_2 + R_1)$$

$$\delta < r^2 >= 2\ R_1 \Delta R + (\Delta R)^2 = \frac{2R_{k\alpha,1}\Delta R}{V_{2,1}} + (\Delta R)^2$$

After doing some math:

$$\Delta R = \frac{1}{V_{2,2}}\left[\Delta R_{k\alpha} + R_{k\alpha,1}\frac{V_{2,1} - V_{2,2}}{V_{2,1}}\right]$$

Correlation matrices can be used to get best $\delta < r^2 >$, likely limited to the relative precision of $\Delta R_{k\alpha}$ due to high level of correlation

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~1e-3

<< $2\ R_1 \Delta R$

After doing some math:

~4

~5(4)e-4

$$\Delta R \ = \frac{1}{V_{2,2}}\left[\Delta R_{k\alpha} + R_{k\alpha,1}\frac{V_{2,1} - V_{2,2}}{V_{2,1}}\right]$$

~1e-3

O(e-2)

O(e-3)

Based of estimates, left term about 10x bigger than right term

Correlation matrices can be used to get best $\delta < r^2 >$, likely limited to the relative precision of $\Delta R_{k\alpha}$ due to high level of correlation